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(71) Applicant *(for all designated States except US)*: LA FEDERATION FRANÇAISE DE CONTROLE LAITIER (F.F.C.L.) [FR/FR]; 149, rue de Bercy, F-75595 Paris Cédex 12 (FR).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: BAZIN, Serge [FR/FR]; 36 bis, rue Dunois, F-75013 Paris (FR). BECHU, André [FR/FR]; Montembourg, F-53500 Saint-Pierre-des-Landes (FR).

(74) Agent: VUILLERMOZ, Bruno; Cabinet Laurent & Charras, 20, rue Louis-Chirpaz, Boîte postale 32, F-69131 Ecully Cedex (FR).

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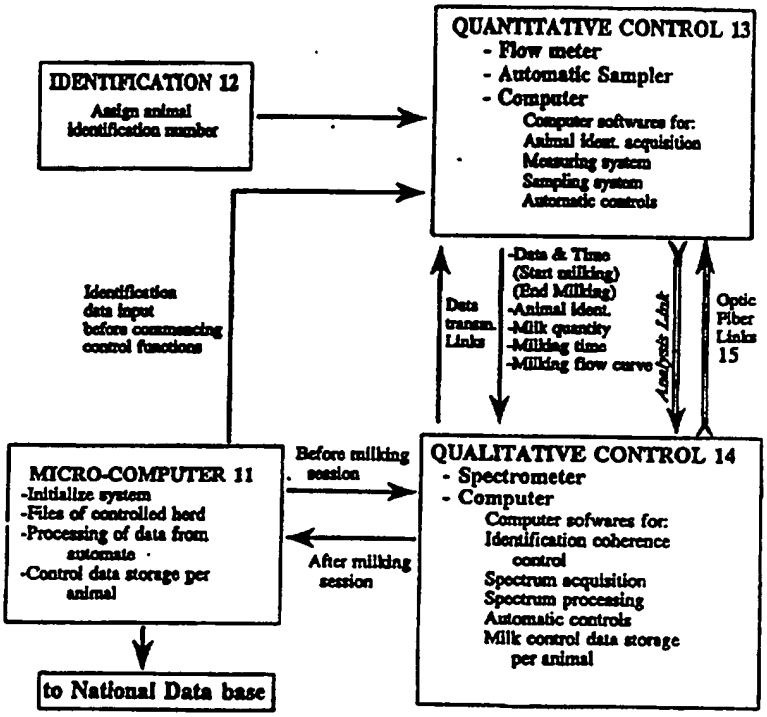
(54) Title: SYSTEM AND METHOD FOR MONITORING AND CONTROLLING MILK PRODUCTION AT DAIRY FARMS

(57) Abstract

An automated modular system for officially controlling the quantity and quality of milk production at a dairy farm site, including the steps of: assigning each dairy herd an identification code; assigning each milk producing animal in each herd a unique animal identification code; providing means f r measuring quantitative milk production from an individual animal using a milk flow meter temporarily connectable with a milking machine for an individual animal, which milk flow meter is capable of continuously weighing milk produced per unit time by an individual animal during a single milking session; providing means for qualitative analysis of the composition of a sample of milk from an individual dairy animal, which means includes an infrared optical probe; providing system control and memory means connected to the milk flow meter and to the means for qualitative analysis; entering a dairy herd code into the system control means and thereby initiating control of the herd and accessing stored data for said herd and each individual dairy animal therein; entering an individual dairy animal identification code in the system control means when the c rresponding individual dairy animal is present at the milking machine, thereby activating the milk flow meter; measuring quantitive milk production from the individual dairy animal; qualitatively analyzing a sample f milk from the individual dairy animal; detecting completion of milking session as indicated by said milk flow meter, and storing in the system memory data from the milking session.



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SYSTEM AND METHOD FOR MONITORING AND CONTROLLING MILK PRODUCTION AT DAIRY FARMS

BACKGROUND

While dairy farming is by now a centuries old business, the economic realities of modern life, as well as the governmental requirements for sanitary milk production and handling and qualitative control of milk to be publicly marketed, provide additional challenges for dairy farmers. The quantity and quality of milk produced on a dairy farm of course originates with the quantity and quality of milk produced by each dairy animal, whether it be cow, goat, ewe, or other milk producing animal. Information concerning the quantity and quality of milk produced by each dairy animal, and understanding and management of that information, can provide dairy farmers with useful information with which to better manage the operation of a modern dairy farm, improve herd selection, prevent illness and increase profits.

Dairy control agents or officials exist in all developed countries. In the U.S.A. they belong to Dairy Herd Improvement Association, Inc. (D.H.I.A.) They may belong to professional groups or associations or to government administrations depending on how the dairy profession is organized in a specific country.

In general, in all developed countries, dairy control agents temporarily install their calibrated milk meters, from which they make a proportional sample. This sample is obtained by mechanical and manual means. Then the samples are bottled and labelled for transportation to a district laboratory where they are analyzed the day after, sometimes 2 days to as many as 8 days, after sampling actually occurs. The laboratory returns the results f the analysis and the bottles are washed, sterilized and r -used. In practice the results ar

r turned from th laboratory about one we k after th analysis, and valuated by the dairy control agent about 10 days, or more frequently about one month, following sample collection at the farm.

BRIEF SUMMARY OF THE INVENTION

The present invention is intended to provide a system for greatly improving milk quality control by milk control agents or officials and to reduce costs, the system being in compliance with the guidelines of the International Committee for Animal Recording (ICAR). It is also intended to provide an inviolable, transportable control system. It is also intended to improve the ability of dairy farmers to monitor and control milk production at dairy farms.

It is a further object to reduce the costs and thus improve the profitability of dairy farming.

It is a further object to provide real-time instantaneous analysis of milk from each dairy animal, i.e., any domesticated milk producing animal, at an individual dairy farm, thereby largely eliminating dangers of pre-analytical errors due to poor or confused milk samples, or degradation of samples during shipping and storage before analysis.

It is a further object to provide immediately available test results on milk samples thereby permitting immediate remedial steps to improve milk quality.

Ultimately it is still a further object of the present invention to provide a system of organizing information by which the desirable genetic make-up of individual dairy animals of a dairy herd may be improved over time.

The advantageous system of the present invention for monitoring and controlling milk production at a dairy farm, includes the use of a link d system of computers

and data input d vices to provide a system for identifying each dairy animal with a unique alpha and/or numeric code with a validation system for checking and confirming that the animal code exists in the herd data base, that there are no code duplicators and that the corresponding animal was not already milked during the current session, measuring the individual quantities and coordinates of the points of the milk flow curve per animal, herd and session, sampling of milk produced by each dairy animal; and real-time instantaneous qualitative analysis of a proportional milk sample from each animal which is representative of the quality of the total milking, since the content of various constituents, like fat, vary during a milking session; collecting and organizing data derived from the quantitative and qualitative measurements concerning the milk produced by each dairy animal of a particular dairy herd. The present invention being for controlling and improving dairy herds, it includes the procedures to deliver temper-proof results, like the coherence test of the control session data per animal with the corresponding data from previous controls. These coherence tests include comparisons of milk flow and lactation curves, and milk production by milking time ratios. This system and its above-indicated objects are achieved by the present invention as described in greater detail below herein.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantageous system of the present invention will be better understood by reference to the accompanying drawings, wherein:

Fig. 1 is a schematic chart showing relationships among some principal parts and functions of the fully automat d mode of the inventive system;

Fig. 2 is a schematic chart showing relationships among some principal parts and functions of the semi-automated mode of the inventive system;

Fig. 3A is a schematic drawing showing the optical analysis probe of the system of the present invention located within the milk meter of the system in conjunction with other elements of a milk meter;

Fig. 3B is a schematic drawing showing the optical analysis probe of the system of the present invention located outside the milk meter of the system with connections for directly circulating a milk sample from within the milk meter to and from the optical analysis probe.

Fig. 4 is a schematic chart showing relationships among some principal parts and functions of an infrared spectrum analyzer of the systems of the present invention.

Fig. 5 is a schematic chart showing relationships and interactions among parts and functions of one preferred embodiment of the inventive system which is intended virtually fully to automate the quantitative and qualitative analysis and management of dairy farm milk production; and

Figs. 6A and 6B are schematic charts showing relationships and interactions among parts and functions of another preferred embodiment of the inventive system which is intended partially to automate the quantitative and qualitative analysis and management of dairy farm milk production.

DETAILED DESCRIPTION

Before describing specific preferred embodiments of the advantageous system of the present invention, it is useful to provide an ov rvi w of such embodiments to have

a better und rstanding of the system as a whole and the individual elements of the inventiv system.

An initial objective of the system is to provide individual identification of each dairy animal at any farm utilizing the inventive system. Such identification can typically be embodied in an alpha and/or numeric code assigned to each dairy animal. All data relating to that animal and its milk production are then always accompanied by the specific animal's unique alpha/numeric code identifier, the code of the dairy herd and the milk flow meter code.

Such individual codes may be monitored by any one of several monitoring or data-logging techniques. However, desired techniques for this purpose including manually inputting the code and data into the milk meter's memory if the meters are connected, the milk meter's memory and the analyzer's memory if not, by keyboard inputting, or automatically inputting data accompanied by an individual animal code by having such data transmitted by radio transponder to a receiver at the memory of the milk meter.

For the purpose of measuring quantitative production of milk by each dairy animal and the rate of production by each animal, an electronic flowmeter or milk meter capable of measuring instantaneous flow rates is used, which also can measure and record the total quantity of milk produced during each milking session and each control period, usually each 24 hours, by each animal. This data can be organized as desired. For example, it may be organized and presented as a milk productivity graph or curve for each animal, each herd, each farm, each milking session or the like.

Additionally, the system of the present invention provides v ry significant advantages with r spect to automatic sampling during milking of an individual dairy

animal, as w ll as the capability of instantaneous analysis of a milk sampl taken at any tim during milking of an individual dairy animal. The milk meter is designed to generate automatically, continuously during the milking and at other times, a proportional milk sample which is representative of the average quality of the total milk produced during the milking session, which sample will be analyzed at the end of the milking session after the milking unit vacuum is interrupted. In fully automatic mode, the sample is not individualized and cannot be modified. For example, using the system of th present invention it is possible to take a sample of an individual animal's milk produced early during each milking as well as near the end of each milking, and to qualitatively analyze the primary constituents of each sample instantaneously during or immediately after milking.

One of the difficulties in measuring milk production particularly during or immediately after milking, is the air content of fresh milk which produces a significant foam volume and variations in density between commencement of milking and completion of milking. In order to overcome that problem applicants found that continuously weighing milk during production and at the completion of the milking session for each animal provides an approach which is substantially unaffected by the air content and variations in volume and density caused by air content.

The desired qualitative analysis of a milk sample can be carried out by infrared spectrometry through a probe present in the analysis compartment of each milk meter and connected to a spectrometer analyzer. The probes are on line with the analyzer. Light emitted by the analyzer goes to the probe through an optic fiber and comes back from the probe to the analyzer through anoth r

optic fiber r is c nverted into el ctronic signals which are transmitt d to the analyzer through an l ctronic conduit. It is in the analyzer that the reflected or transflective beam is analyzed and converted into numeric data.

At the end of each milking session, the milk meter automatically sends a signal to the analyzer which then starts the analysis. The results of this analysis are immediately stored in memory and available on a computer screen or printer. Information from the probe at the site of sample testing, i.e., at the farm or test site, can be instantaneously transmitted to the spectrometer, and the spectrometer analysis data are instantaneously available, thereby providing the basis for instantaneous management of milk quality during or immediately after milking of each individual dairy animal. These data can also be transferred by modem to the national files at the end of the control session, specially for the Genetical Indexation.

Not only milk control authorities and farmers are interested in such a system but also sanitary control authorities, genetic authorities and agricultural researchers, and the like, who will be able to collect a considerable amount of information and comparable statistics about the season, geographic area, breed, and food influences on milk quality and quantity. Dairy product industries are also interested because better and faster control will increase their confidence in the average quality of milk, and the ability of farmers to bring faster solutions to sanitary problems, since the system is capable of measuring the amount of leucocytes present in the milk of each and every animal. The system is designed for measuring every dairy animal and every milking with respect to milk flow curve, total milk quantity delivered, fat content, protein content,

leucocyte content, casein content, lactose content, urea content, start time and duration of milking, and all other components which can be analyzed by infrared spectrometry. The system described herein fulfills the regulations of the International Committee for Animal Recording.

Another objective of the advantageous system of the present invention was to provide a system for professional and governmental control and analysis of milk at the dairy farm site of production, which system is readily portable, sturdy, shock resistant, and easy to use, service and maintain. In actual practice applicants devised a milk meter for use in the system of the present invention, which milk meter comprises four primary modules, namely a weighing system, a sampling system, an analysis compartment, and an electronic control and memory system.

The weighing system comprises at least one, and preferably two containers, each of which has an electronic weight sensor or scale associated therewith. Such containers are also associated with a filling and emptying system which is capable of very rapid switching to minimize interruption of continuous milking of the individual dairy animal producing the milk being analyzed. In the preferred system where two containers are each associated with electronic weight sensors, the fast switching valve or distributor is maintained in its open position during the filling operation, or emptying operation, of one of the two containers, and then is capable of rotating almost instantaneously to a second position in which the second container is filled and the first container is emptied through hoses associated with the fast switching valve.

The sampling system comprises a static, pitot tube-like device located in a milk flow line and operates

based on the difference between the dynamic pressure of milk flowing in that line and the static pressure within the pitot tube-like device. The sampling system is based in a milk flow line located in the milk meter downstream from the weighing system described above. This sampling system gives the milk meter the ability to continuously sample a proportionate part of the milk passing through the meter, typically about 2% of the milk production, and the continuously sampled portion of the milk is accumulated as a cumulative sample of the milk produced from an individual dairy animal during a single milking session. At the conclusion of a milking session for an individual dairy animal this cumulative sample is conveyed to a sample compartment within the milk meter, and from that sample compartment a fixed volume test sample is removed for qualitative analysis.

The analysis compartment is removable from the milk meter and typically contains the optical probe and an agitator, or alternatively is closely associated with the optical probe which is outside the analysis compartment and milk meter, and to and from which a milk sample from within the milk meter is circulated for qualitative analysis. Such a circulation system typically involves pumping a sample of milk from the milk flow meter to and from the exterior optical probe. The analysis compartment is not only a separate compartment, but is also separately operable vis-a-vis other portions of the milk meter and system generally, and this separate operability facilitates faster milking and analysis operations since analysis can proceed even if the milk meter has been activated for metering the milk production of a different individual dairy animal from the one which produced the sample to analyzed.

The electronic control and memory system includes a microprocessor, keyboard, RAM memory, magnetic memory and

interfaces among its various components. This system is directly on line with the electr nic weight sensors and causes the switching valve to change position when th weight of the container being filled reaches a maximum for which it has been designed, or receives milk for a maximum filling time. Since the quantitative analysis portion of the milk meter operates continuously to provide quantitative milk production data in weight per unit time, either weight or time may be used as the limiting factor for certain related operations. Th electronic control and memory system also ensures proper signal acquisition from the automatic identification system, and ensures accurate storage of codes and other data. The memory accurately stores animal codes entered at the keyboard. By entering a dairy herd code into the system control means, control of the individual animal code list and data for a specific herd is initiated and stored data for that herd and each individual dairy animal therein is accessed. These things typically occur when the system control and memory means is connected to the milk meter and to the qualitative analyzer.

The control system also calculates milk production per individual dairy animal by adding the weight per unit time data produced by the quantitative measuring system. Then the system records in the memory data from each milking session of each individual dairy animal associating with that dairy animal's unique code the quantity of milk produced, the start time, duration of milking and quantities of milk produced per unit of tim throughout that milking session. All such data, including corresponding qualitative analytical data, ar stored in the system memory for each individual dairy animal for each milking session. Where applicable, appr priate data are also transferred from the control system to the qualitative analyzer. The control system

also monitors milk flow rate throughout a milking session, and indicates milking completion when the flow rate decreases below the minimum milk production rate generally accepted for the species of dairy animal being milked.

The various components or modules of the overall system can operate independently, or connected by twos, by threes or altogether by one of the various means available, including those discussed above herein, and the operation of each portion of the system is coordinated by appropriate software permitting the various modules of the system to interact appropriately to achieve the desired analytical and data processing results. When all the milk flow meters are connected as a network, the whole system may be monitored by the analyzer or by the microcomputer according to the configuration chosen by the local control officers. In many cases the computer is used only to input data into the milk meters and the analyzer memories before starting the control session, and to collect and validate the new data after the end of the control session. The specific data processing is of course the function of appropriate software for the components of the system, milk meters, analyzer and computer used. While those skilled in the art may choose to formulate such software in a variety of different modes and sequences, generally, such software should be capable of performing the functions indicated in this specification.

The foregoing overview of the system of the present invention can also be understood in relation to Figures 1 and 2, schematic diagrams of some of the modules and functions of the system of the present invention. Figure 1 schematically illustrates a fully automated system. Upon installation of the system at the farm, the microcomputer 11 is linked to a quality control module 14 for

transferring to the combination of the modules of the system th information n c ssary to its successful functioning. It includes the dairy herd or farm data with the list of that herd or farm's dairy animals, their codes and associated statistics. The micro-computer 11 may not remain linked to the system during the control operations because according to the organization of the control, it may remain connected or not. During the control three modules remain at the farm: a module 12 for individual identification of the dairy animals linked to the sampling module and the quantitative control 13 of the production of each identified dairy animal. The coherence of the identification and associated data is ensured by a system described elsewhere herein. At the conclusion of the milk control operations, the micro-computer is the new link to the quality control module 14 for collecting and holding the results of the identification modules 12 associated with the quantitative control modules 13 and with the qualitative control modules 14. The micro-computer also collects the milk flow and the lactation curves per animal, and makes the coherence tests before the validation of all the data and their transmission to the genetic data base.

The micro-computer 11 includes programs for processing the various types and individual items of data received from the other modules linked to the computer, and these data processing techniques and programs are generally indicated in Figure 1. Additionally, arrows in Figure 1 generally indicate the existence of numerous computer links and interfaces between individual dairy animals or data gathering or processing modules associated with individual dairy animals or into which data accompanied by the alpha/numeric identifying code of individual dairy animals exists and from and to which data is transmitted to and r ceived from oth r modul s of

th system, particularly including th micro-computer. Also, as indicated, certain communication links between the automatic sampler and the qualitative control spectrometer are optic fiber links 15. Such links may be any useful two-way optical transmission devices, optical fiber cables being a preferred example.

Figure 2 schematically illustrates a semi-automated system having many, but not all, of the elements, functions and advantages of a fully automated system. For example, it is readily apparent that there are no optic fiber links in this embodiment, and milk samples 16 are manually transferred by milk control officers to avoid any fraud from the sampler at the flowmeter in 13a to the separate spectrometers in 14a.

The milk sample, typically a minimum volume of 8 ml., is manually transferred to a special compartment for viewing by the analyzer. The dairy control agent keyboards in the animal code for the milk to be analyzed. Thus there is control of the validity of the code according to a procedure described in the present invention. If the identification is good, the analyzer evacuates the sample of milk toward the optic probe. When the analysis is complete, the analyzer evacuates the milk sample toward a pail or flask for that purpose outside and separate from the analyzer. In no case is the micro-computer 11a operating as a link between the meter and the analyzer. The schematic drawing effectively indicates a micro-computer 11a link to the milk meter 13a to collect the quantitative control data. Furthermore the micro-computer 11a will be linked to the analyzer 14a to collect qualitative control data. The milk meter data and the analyzer data are linked in the micro-computer by means of the identification codes of the dairy animals. Th micro-comput r may also validate the identification cod entries in the milk meters and

validat th data of th control session and test their coherence with pr vi us data per dairy herd, dairy animal, and milking session.

More specifically, the advantageous system of the present invention makes use of two types of modules or systems for entry, collection or transmission of initial data. The first is a data input keyboard associated with the electronics of each milk flowmeter connected to each milking machine or claw. The second is a transponder physically associated with each animal and capable of transmitting a radio code in response to receipt of a polling pulse from a data collection receiver. Similarly, the transponder on each animal may be temporarily connectable directly to the electronic system so that data can be directly transmitted from the animal to a data collecting computer memory, which makes possible the validation of identification codes by the computer.

Such data collecting computer memory is associated with a transmitting and receiving system compatible with the system associated with the milk meter used on the milking machine or claw used for a particular dairy animal. An identification receiver is typically connected to a milk meter by RS232 type connection or infrared connection. In the fully automatic mode, the animal identification code is transmitted to the analyzer as soon as it is registered at the milk meter. The analyzer includes software for checking identification validity. When the milk flow meters operate separately, the control systems of the milk meter confirms that the particular animal identification code exists in the data base for the herd or farm, and whether an animal having that code has not already been milked. If already milked, the m t r will accept the code and milking data but will register and transfer that milking data to the

computer with a notation of duplication or error. In the semi-automatic mode, the animal identification cod entered at the milk meter does not become part of the validation check. On the other hand the animal identification code entered manually at the analyzer can be checked. If the milk meters form a network, a micro-computer located at the end may check identification code validity. The animal identification code is transmitted to the analyzer which is associated with the quantitative control data when the end-of-milking signal is initiated. After the analysis, the analyzer stores in its memory all the data of the milking by milk meter and animal the quantity produced, coordinates of the milk flow curve points, starting time and duration of the milking received from the milk meters plus the results of analysis by animal and by milking session. These data are transferable to a micro computer.

Of course the data receiving computer will include software to initiate signal acquisition from a transponder on each dairy animal through the flowmeter being used on the milking unit on each animal to verify proper identification of the alpha/numeric code identifier received from each animal and to alert the system operator and the system itself to any data acquisition errors, such as an erroneous animal identifying codes not present in the system, or duplicate acquisition of an identification number.

For the purpose of measuring the quantity of milk production, the rate of milk production and to conduct instantaneous sampling at any time during the milking of an individual dairy animal, the quantitative metering/sampling apparatus includes processor and memory which are capable of storing the previous data and statistics of the dairy herd, recording the milking times and dates, recording rates of milk production, and

calculat the coordinat s of the points constituting the milk flow curve during any milking, m asuring and recording overall milk production at any milking, periodically collecting and building up a sample representative of any overall milking of an individual animal; transferring all or part of a sample to an analysis container or compartment for qualitativ analysis; and finally washing all of the wet parts of th flowmeter at the conclusion of the milking session of all animals. For these purposes there is one flowmeter connected to each milking machine or claw, or available at each station or stall at which an individual dairy animal is milked.

Qualitative analysis of a milk sample from any individual dairy animal is carried out in th advantageous system of the present invention by use of an optical probe which is capable of performing a transmissive or transmissive/reflective optical analysis of a liquid milk sample, and the detected results are transmitted to an infrared spectrometer via fiber-optic cable linkage. In the system of the present invention such an infrared spectrometer is preferably linked to a plurality of optical probes one of which is located in each of a plurality of flowmeters each associated with a milking machine or claw at an individual station or stall at which a dairy animal is milked. The optical probe may be located in an analyzing compartment or in a loop through which the milk sample circulates, and it is in that compartment that the transmissive or transflective analysis is carried out by the optical probe, the results of which are transmitted via optic fiber cable to the more centrally located infrared spectrometer. This infrared spectrometry is carried out using a range of wavelengths of infrared light appropriate for the desir d results. To date, effectiv results have been achiev d

in the so-called near-infrared portion of the spectrum, although it may be possible to use other frequency ranges at least somewhat beyond the known near-infrared frequency range. Fig. 3 schematically shows the desired optical analysis test probe of the advantageous system of the present invention in conjunction with other elements of the milk meter used in such a system. As shown in Fig. 3, milk meter 30 includes sample compartment 31 in which or adjoining which is located an optical probe 34. In the embodiment illustrated in Fig. 3, a milk inlet 32 communicates to an analysis compartment 33 in which optical probe 34 is located. Analysis compartment 33 may also contain an agitator 35 to maintain homogeneity of the sample being tested. After testing is complete a milk sample exits analysis compartment 33 through drain 36. In an alternative embodiment the milk meter/probe combination may be assisted by a pump which will force or entrain milk of the sample into the optical path of the optical probe 34.

The optical test probe of the present invention may typically be used in one of two modes in the advantageous system of the present invention. In one mode, the operative tip of the optical probe is immersed in the milk sample to be analyzed, and in this embodiment it is desirable to agitate the milk in the sample being tested to ensure homogeneity of the sample. In the other mode the probe is not merely immersed into the milk sample, but rather the milk sample is supplied to the probe by a pump system which forces or entrains the milk sample to be analyzed through the optical path of the test probe. It is believed that either probes with regular or straight optical paths may be used in the advantageous system of the present invention.

In addition to rinsing external portions of the optical test probes of the present invention with water

after each milking session of all dairy animals, the cleanliness of the sample compartment, milk inlet, and optical path of the test probe may be facilitated by rinsing with a portion of the milk test sample to be used before optical testing is actually conducted.

In the typical system installation where it is likely that a number of dairy animals are being milked simultaneously and thus a number of flowmeters are in simultaneous operation on a number of milking units, the infrared analyses being carried out by optical probes in several different flowmeters can be monitored simultaneously using a multi-channel optical switch to sweep the feedback from all probes in all flowmeters in simultaneous use.

In modern infrared spectrometers, the electronic spectrometer control system is capable of managing all of the spectrometer functions including spectral analysis as well as appropriately linking the spectrometer to other portions of the systems such as the flowmeters or probes located in flowmeters, as well as linking the spectrometer output or data collection memory with an appropriate data processing computer and its memory. In this way, the electronic spectrometer control can store all qualitative data relating to each dairy animal from which a collected milk sample has been analyzed, and data from previous analyses of previous samples originating from the same animal are also stored for purposes of comparative data analysis and ensuring that any animal identification error or other mis-matching of data with originating animal is avoided or duly marked with a duplication or error warning.

An embodiment of an infrared spectrum analyzer for use in the advantageous system of the present invention is schematically illustrated in Fig. 4. In that schematic diagram, spectral analyzer 40 is shown in

conjunction with test prob 34, the source of th input information being analyzed. The spectral analyzer 40 is operated from 24 volt and 75 watt power sources connected through appropriate electrical filter adapter equipment. A modulator connected through a detection synchronizer is connected to the test probe, and the output of the test probe is likewise connected to the detection synchronizer. The immediate output of the test probe is connected to an elliptical adapter, a quick 200 mm mono-focal driven by a step supply motor, followed by a lead sulfide (PbS) detector serviced by another supply. The output of these elements is preamplified, and it is that preamplified signal which is input to the synchronization detector for operation coordinated with the test probe modulator. The output signal then passes into step-by-step control systems controlled by a micro-computer. Those control steps include passing the output signal through an analog filter, then an analog offset then a programmable offset and then a programmable amplifier, after which the signal is processed in an analog-digital converter to result in reconstructed information in the form of a process signal indicative of the optical analysis of a particular milk sample being tested.

The system of the present invention is interactively managed and controlled by various software or software modules which are interconnected and interact through various specific linkages and interfaces. The linkages, interfaces and software modules allow automated analysis and sequencing to occur without impairing the routine work of milking a herd of dairy animals. The software modules include at least individual animal identification controlling software, flowmeter controlling software, sample controlling software, qualitative analyzer controlling software, and more general data management

and data processing software for the computers or microcomputers involved.

This software and associated memories can be thought of in two groups or sets as follows: First, the software provides the capability of collecting data, organizing and managing the data and statistically processing the data collected for each identified dairy animal and each herd or dairy farm utilizing the system. Second, the system includes modules for calibrating the various quantitative and qualitative measurement systems, as well as for analyzing the stored data independently of the real-time data collection/analysis functions.

As previously indicated, the modules of the system are connected to each other through a variety of data links or interfaces, depending upon the nature of th signals or data to be transmitted and to the configuration of equipment used on individual animals. Among these linkages are electrical linkages and optical linkages, typically fiber optic cables, for transmission of optical or electronic signals, particularly those signals associated with spectrometry and the probes carrying out the detection functions which provide the input for the spectrometer. Other portions of the system, such as initial identification of individual animals may occur through linkages via radio wave transmission, by infrared remote control or infrared data transmission. Still other portions of the system may be linked by telephone cables or electrical cables, as desired or required. Particularly, return connections among various elements of the system may be electrical or optical means, as desired.

Various preferred embodiments for employing the advantageous system of the present invention are hereafter explained in conjunction with the schematic charts in Figs. 5, 6A and 6B showing relationships and

int ractions among parts and functions of pr ferred embodiments of the inventive system.

The system interactions in a preferred, fully automated embodiment are illustrated and explained in Fig. 5 in an effort virtually fully to automate the quantitative and qualitative analysis management functions of the inventive system for monitoring and controlling milk production at dairy farms. In this fully automated system sets of quantitative and qualitative analysis modules are connected by a dual optical and electronic data-transmitting linkage. The incident beam through the incident optic fiber comprises treated or split white light emitted by a halogen lamp located in the analyzer. This white light is transmitted and reflected through the probe submerged in a milk sample, or in a flow from a milk sample, and the reflected beam coming back through a second optic fiber is altered by the absorption of part of the spectrum by the different milk constituents. This beam is then analyzed by the spectrometer along a frequency range corresponding roughly to the near infrared. The optical conduit of the linkage is capable of transmitting the infrared signal from the probe to the spectrometer for conducting the qualitative infrared spectral analysis of a milk sample. The electronic conduit is capable of transmitting information between all the modules of the system wherein it may be stored in memory and used to set up, control and monitor the sequence of different automated monitoring steps.

In some embodiments of this system a micro-computer may be used in place of an analyzer. If, for any reason, the analyzer is not available at the farm, the desired control may still be available. Then, data from the milk meters, with id ntification c des, may be collected by a micro-computer, ither on line or through infrared

connection, and th milk samples are transported in a thermally is lated contain r to the nearest laboratory or analyzer. During monitoring, data collection, analysis and control, useful data is obtained, for example a list of individual dairy animals whose samples have been checked as well as the detected production for each such animal, and such data is transferred by the control micro-computer through the analyzer. The analyzer includes a microprocessor and substantial memory permitting it to store a very large number of pieces of data. Among the functions which the analyzer may carry out, are included monitoring individual animal identification per dairy herd per milking session at th various quantitative and qualitative meters or sensors and ensuring that data from a sample from an individual animal is always associated with that animal's alpha/numeric code indicator.

EXAMPLE I

To more fully indicate the system in operation of a virtually fully automated system as illustrated in Fig. 5, the following example indicates a preferred sequence of operations using such a fully automated system:

The meters are connected to the analyzer by an electronic cable or conduit and optical cables.

1) The analyzer/meter modules are operation-ready; the milking station vacuum is maintained in the off condition at the meter to preclude the farmer from connecting his animals as long as manual or automated identification is not carried out. The vacuum is switched on by the identification of the animal to be milked.

2) When the animal identification is performed manually or automatically, a verification procedure is initiated by th analyzer/met r dialogue, as follows:

the animal code is extant	-->	the analyzer validates; the meter becomes operational.
the animal code does not exist	-->	the analyzer asks: new animal? --if yes, farmer validates, analyzer asks for new code, the code is created in the file, and the meter becomes operational. --if no, the analyzer infers logging error and again asks for a code.
the code already was entered	-->	analyzer warns "already milked", analyzer asks if the second animal is ok. --if yes, a "V" will display in the file next to the particular datum, --if no, the analyzer inquires about any double in the herd, --if yes, a D will display in the file next to the particular data, --if no, the analyzer infers recording error and again asks for a code.

The matter will be corrected when the control agent returns.

3) Identification is proper -- the meter reintroduces the vacuum -- the equipment is now operational.

4) The farmer connects the milking machine, i.e., milking claw, to the animal being monitored.

5) Milking takes plac .

6) When the rate drops b low 200 g/min or if th re is no mor milk circulating in the m ter, a time-delay is initiated. At the end of the delay, an alarm is set off to warn the farmer milking is likely complete or there is some difficulty, for instance disconnection of the milking claw.

7) If there is a difficulty, the farmer fixes it and milking continues. If milking is complete, the farmer disconnects the animal and indicates the end of milking by pushing a specific meter key.

Thereupon the vacuum is eliminated at the meter; th farmer cannot connect the next animal as long as the milking sample is not drained into the analysis compartment.

8) When drainage into the analysis compartment is complete, the meter is again ready for use, and

a signal is transmitted to the analyzer which then may analyze.

9) The analyzer initiates analysis.

10) Upon completion of analysis, the results are compared with a reference range.

If results are deviant from the reference range to which they are compared, the analyzer initiates a re-analysis. However this operation can take place only once in order not to slow milking.

If the results appear consistent, the analyzer transmits an end-of-analysis signal to the meter.

(11) The analyzer is ready for another analysis.

The meter initiates the drainage of the analysis compartment which thereby is ready for the next sample.

12) When all dairy animals have been milked, the farmer initiates a wash function on each milk meter.

This command transfers the meter data to the analyzer wher they are stored. The data transfer from

the milk meter may, where called for, take place following th milking of each animal rather than at the end of milking the full herd. Upon completion of data transfer, the analyzer will be in stand-by status until the next morning. The monitoring procedure applies to all milkings during a desired control period, typically each 24 hours. The analyzer should remain electrically powered to preserve the inner temperature of the apparatus. Otherwise there may be a wait of 15 to 20 min the next morning for the apparatus to warm up to initiate the monitoring procedure, depending upon the particular apparatus actually used. Also, the analyzer should remain in standby primarily to maintain in the analyzer memory the initiation procedure adopted at analyzer set-up at the farm. In particular this procedure serves to check proper operation of the links between the milk meters and the analyzer and to calibrate the analyzer as a function of the length of the optical cables.

13) The analyzer is restarted by introduction of an identification code at the milk meter.

When the equipment is set up at the milking site, the agent feeds from his micro-computer all data necessary for the monitoring procedure to the automated equipment portion: list of monitored animals, estimates of their production allowable reference limit rates depending on herd's breed.

When the equipment is removed from the milking site, the agent retrieves the monitoring data by hooking his micro-computer to the analyzer. Thereupon he may evaluate the data and advise the farmer on his herd management.

In addition to the fully automated embodiment described above herein, the system may be embodied in one or more semi-automated modes and still achieve a variety of the desired results. This other preferred embodiment

of the present invention is illustrated in Figs. 6A and 6B which are schematic charts showing r lationships and interactions among parts and functions of the inventive system intended to partially automate the quantitative and qualitative analysis and management of dairy farm milk production. This semi-automated system includ s both an analyzer and electronic meters although the analyzer and meter modules are no longer connected by a dual optical/electronic data-transmitting linkage.

In this system each animal being milked is identified by its alpha/numeric code identifier by entering such data in the monitoring means present during milking, and the milk sample to be analyzed from each such identified animal is manually transferred from the flowmeter to the analyzer by the dairy control agent present at the farm. The transfer and collection of flowmeter data takes place at the initial set-up and again at the time of removal of the equipment from an individual dairy farm where the semi-automated system has been at least temporarily installed. In this system any dairy control agent must connect his micro-computer to each flowmeter in order to carry out the desired operations of the overall system. Alternatively, if the individual meters are interconnected in a network format, or by infrared connection, the agent's micro-computer is connected to that network to carry out the desired overall operation. Similarly, the agent's micro-computer must be connected to the analyzer to provide, at least temporarily, a complete system.

EXAMPLE II

To better understand this type of semi-automated equipment including both an analyzer and electronic flowmeters, th following example is presented to indicate pr f rr d operations and s quence in conjunction

with the type of system illustrated in Figs. 6A and 6B. These figures illustrate a configuration wherein the milk meters are interconnected. When they operate separately, the control system of each one is capable to perform the same tests to validate the animal identification but can only confirm that a particular animal was not already milked by this particular milk meter.

The meters no longer are connected to the analyzer. The two modules are independent from each other, being linked on demand by the dairy control agent. This agent picks up the milk at the meter and feeds it to the analyzer for the qualitative control. He enters the identifying numeral at the meter and analyzer. In this mode, identification can be monitored only at the analyzer.

1) The meter/analyzer modules are operational: the vacuum is eliminated at the meter to preclude the farmer from initiating milking of his animals as long as there is absence of manual or automated identification.

2) If identification is valid, the meter reintroduces the vacuum and the milking equipment becomes operational.

3) The farmer connects the milking claw to the animal being checked.

4) Milking proceeds.

5) When the rate drops below 200 g/min or if no more milk circulates in the meter, a time-delay sets in. At the end of the delay, an alarm notifies the farmer of the likely end of milking or of a difficulty such as the milking claw being disconnected.

6) If a difficulty is encountered, the farmer fixes it and milking proceeds to conclusion.

If the milking is concluded the farmer disconnects the animal and confirms the end of milking by pushing a special meter key. The vacuum is then

liminat d at the milk m t r. The farmer cannot connect th next animal as long as the particular milk sample has not been collected by the dairy control agent.

7) Sampling is finished.

The agent replaces the full sample flask by another empty one. He initiates a function which again readies the meter for operation.

8) The agent pours the sample into the analyzer's analysis compartment.

9) The agent enters the identifying code of the particular animal on the analyzer keyboard. Th identification check then begins:

there is such an animal code	-->	a n a l y z e r confirms the step.
there is no such animal code	-->	analyzer asks: new animal? --if yes, the agent confirms, the analyzer asks for the new code, the code is created in the file, the analyzer becomes operational. - - i f n o , analyzer deduces recording error, analyzer asks for a code again
the code already was entered	-->	analyzer states " a l r e a d y m i l k e d : , analyzer asks if second animal is ok. --if yes, a V is display d in the file n xt to the aff cted datum.

--if not, the analyzer inquires about any double in the herd.
--if yes, a D will be displayed in the file next to the affected datum,
-- if not, the analyzer infers a recording error and again asks for a code.

10) When identification is proper, analysis begins.

11) When the analysis is completed, the test results are compared with a reference range.

If the results appear deviant, the analyzer initiates a re-analysis. This operation may take place only once in order not to slow milking.

If the results appear consistent, the analyzer drains the sample into a flask or suitable pail.

12) The analyzer is ready for another analysis.

13) When all animals have been milked, the agent will set the analyzer on stand-by until the next morning. The monitoring procedure extends over two milkings. The analyzer should remain electrically powered to maintain the internal apparatus temperature as otherwise there would be a wait the following morning of 15 to 20 min. to raise its temperature before the monitoring procedure could be initiated.

In various embodiments of the invention a micro-computer may be connected to a plurality of milk meters to confirm individual dairy animal identification codes in the event of analyzer malfunction or in the absence of an analyzer, or in the semi-automated mode where such assistance in animal identification may be required or desired, such as where the individual farmer caring for the herd at a particular time is not familiar with the herd. In the latter case, it is desirable to include in the system a data-transmitting linkage through which individual animal identification data can be correctly input.

In other instances, where the system equipment is at least temporarily set-up at the milking site at a dairy farm, the operating agent can transmit from his micro-computer all data required for identification checking procedures. He can transfer the specific data to each milk meter, including a list of identified dairy animals and estimated or previously recorded production data. Similarly, the agent can make available to the analyzer the same list of identified animals and any limiting specifications for those animals depending upon the particular breed of the dairy herd in question. When the analytical procedures are completed and the equipment is removed, the agent retrieves all of the data of the test procedures by connecting his micro-computer to each milk meter as well as the analyzer. The data collected from the meters and the data at the analyzer are then combined in accordance with the identifying codes at the micro-computer. In this way, the agent present at the on-site testing may evaluate the data and advise the dairy farmer on the spot concerning how to improve quality, productivity and management of his dairy herd.

WHAT IS CLAIMED IS:

1. An automated method for controlling the quantity and quality of milk production at a dairy farm site, operable by a milk control authority for compliance with international genetic, zoological and sanitary regulations and norms, comprising using at least two modules of a modular system to carry out steps comprising:

assigning each dairy farm or herd a unique identification code;

assigning each milk producing animal in said dairy farm or herd a unique animal identification code;

providing means for measuring quantitative milk production from an individual dairy animal using a milk flow meter temporarily connectable with a milking machine for an individual dairy animal, which milk flow meter is capable of continuously weighing milk produced per unit time by an individual dairy animal during a single milking session;

providing means for qualitative analysis of the composition of a sample of milk from an individual dairy animal, which means includes an infra-red optical mode associated with said milk flow meter said infra-red probe being capable of detecting qualitative composition of milk;

providing system control and memory means connected to the milk flow meter and to the means for qualitative analysis;

entering a dairy herd code into the system control means and thereby initiating control of the herd and accessing stored data for said herd and each individual dairy animal therein;

entering an individual dairy animal identification code in the system control means when the corresponding individual dairy animal is present at the milking machine, thereby activating the milk flow meter;

measuring quantitative milk production from the individual dairy animal at th milking machine using said means for measuring quantitative milk production, thereby continuously charting the milk flow curve for said animal;

qualitatively analyzing a sample of milk from the individual dairy animal at the milking machine using the infra-red optical probe associated with the milk flow meter;

detecting completion of milking session as indicated by said milk flow meter, and entering a completion of milking signal into the system control means; and

storing in the system memory data from the milking session.

2. The method of claim 1 wherein the quantitative and qualitative data for each individual dairy animal are stored for each control session, a control session comprising such data for all milking sessions for each animal during a 24-hour day.

3. The method of claim 1 wherein said flow meter continuously creates a cumulative sample of milk representative of the quality of the entire milk production of an individual dairy animal during one milking session.

4. The method of claim 1 additionally comprising transmitting data from a milking session to a national or international data base.

5. The method of claim 1 wherein measuring quantitative milk production from an individual dairy

animal occurs in real time continuously throughout a milking session of said animal.

6. The method of claim 1 wherein the infra-red optical probe is within the milk meter.

7. The method of claim 6 wherein the qualitative analysis occurs in real time during a milking session of an individual dairy animal.

8. The method of claim 1 wherein the infra-red optical probe is outside the milk meter and a sample of milk from within the milk meter is directly circulated to and from the probe.

9. The method of claim 8 wherein the qualitative analysis occurs in real time during a milking session of an individual dairy animal.

10. The method of claim 1 wherein qualitative analysis data is transmitted optically via optic cable from said infra-red probe to an analyzer at a site remote from the milk meter.

11. The method of claim 1 wherein qualitative analysis data is transmitted electrically or telephonically from said infra-red probe to an analyzer at a site remote from the milk meter.

12. The method of claim 1 additionally comprising verifying the correspondence between the individual animal code and data from the current milking session with stored data or statistics from prior milking sessions of the same animal, thereby preventing erroneous

or fraudul nt data ntry for any individually coded dairy animal having prior data stored in th system memory.

13. The method of claim 1 additionally comprising storing the milk flow curve data for an individual dairy animal after each milking session of said animal.

14. The method of claim 13 additionally comprising comparing the milk flow curve data from the current milking session for an individual dairy animal with stored milk flow curve data from previous milking sessions of the same animal.

15. The method of claim 1 additionally comprising storing the qualitative analysis data for an individual dairy animal after each milking session of said animal.

16. The method of claim 15 additionally comprising comparing the qualitative analysis data from the current milking session for an individual dairy animal with stored qualitative analysis data from previous milking sessions of the same animal.

17. The method of claim 1 additionally comprising washing the milk flow meter after the completion of each milking session for each dairy herd.

18. The method of claim 1 additionally comprising monitoring for each milking session for each individual dairy animal the sequence of steps comprising milk flow rate measuring, quantitative measuring, and qualitativ analysis.

FIGURE 1

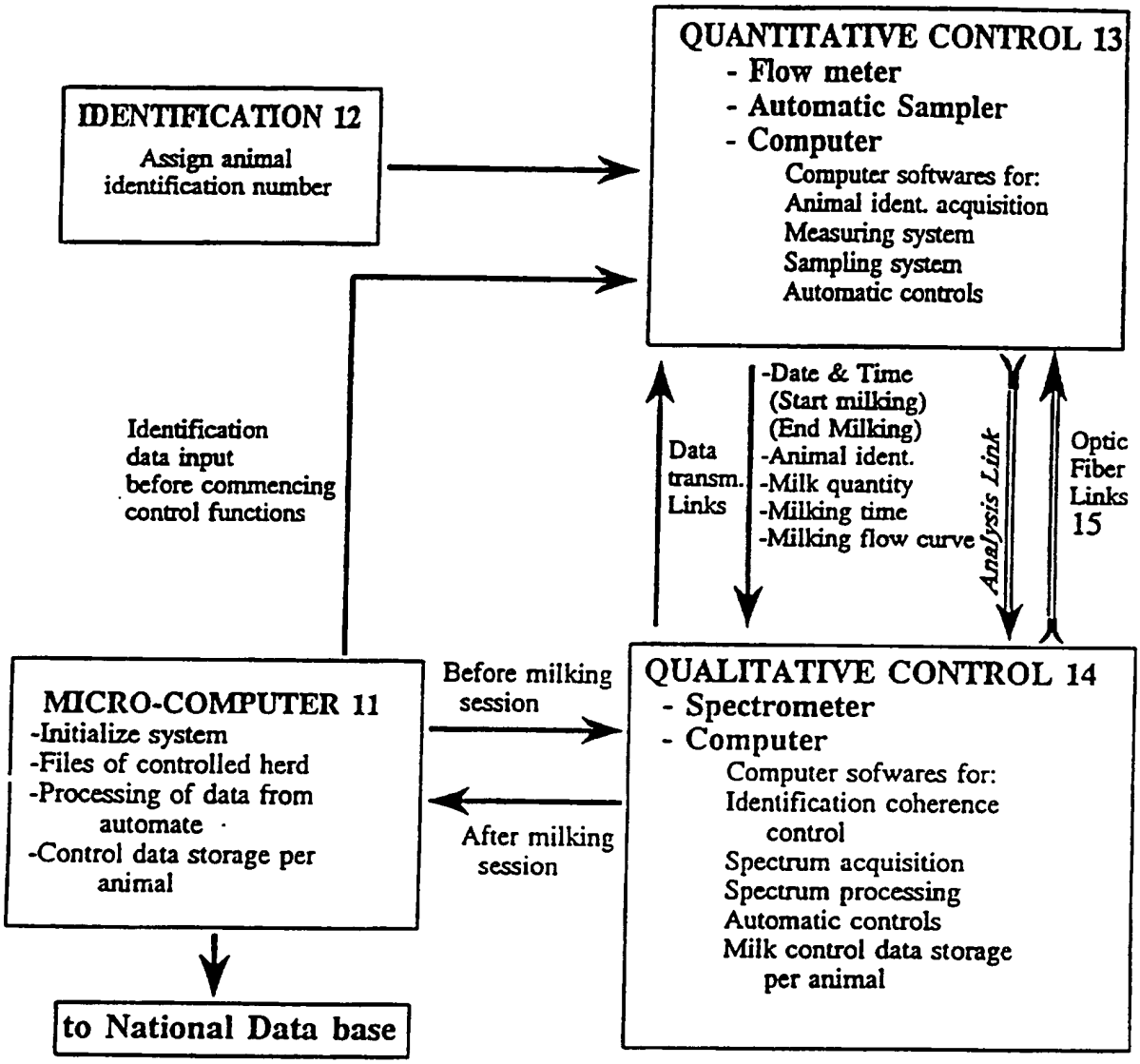

QUANTITATIVE CONTROL 13
- Flow meter
- Automatic Sampler
- Computer
Computer softwares for:
Animal ident. acquisition
Measuring system
Sampling system
Automatic controls
IDENTIFICATION 12
Assign animal identification number
Identification data input before commencing control functions
Data transm. Links
-Date & Time (Start milking) (End Milking)
-Animal ident.
-Milk quantity
-Milking time
-Milking flow curve
Analysis Link
Optic Fiber Links 15
MICRO-COMPUTER 11
-Initialize system
-Files of controlled herd
-Processing of data from automate
-Control data storage per animal
Before milking session
After milking session
QUALITATIVE CONTROL 14
- Spectrometer
- Computer
Computer sofwares for:
Identification coherence control
Spectrum acquisition
Spectrum processing
Automatic controls
Milk control data storage per animal
to National Data base

FIGURE 2

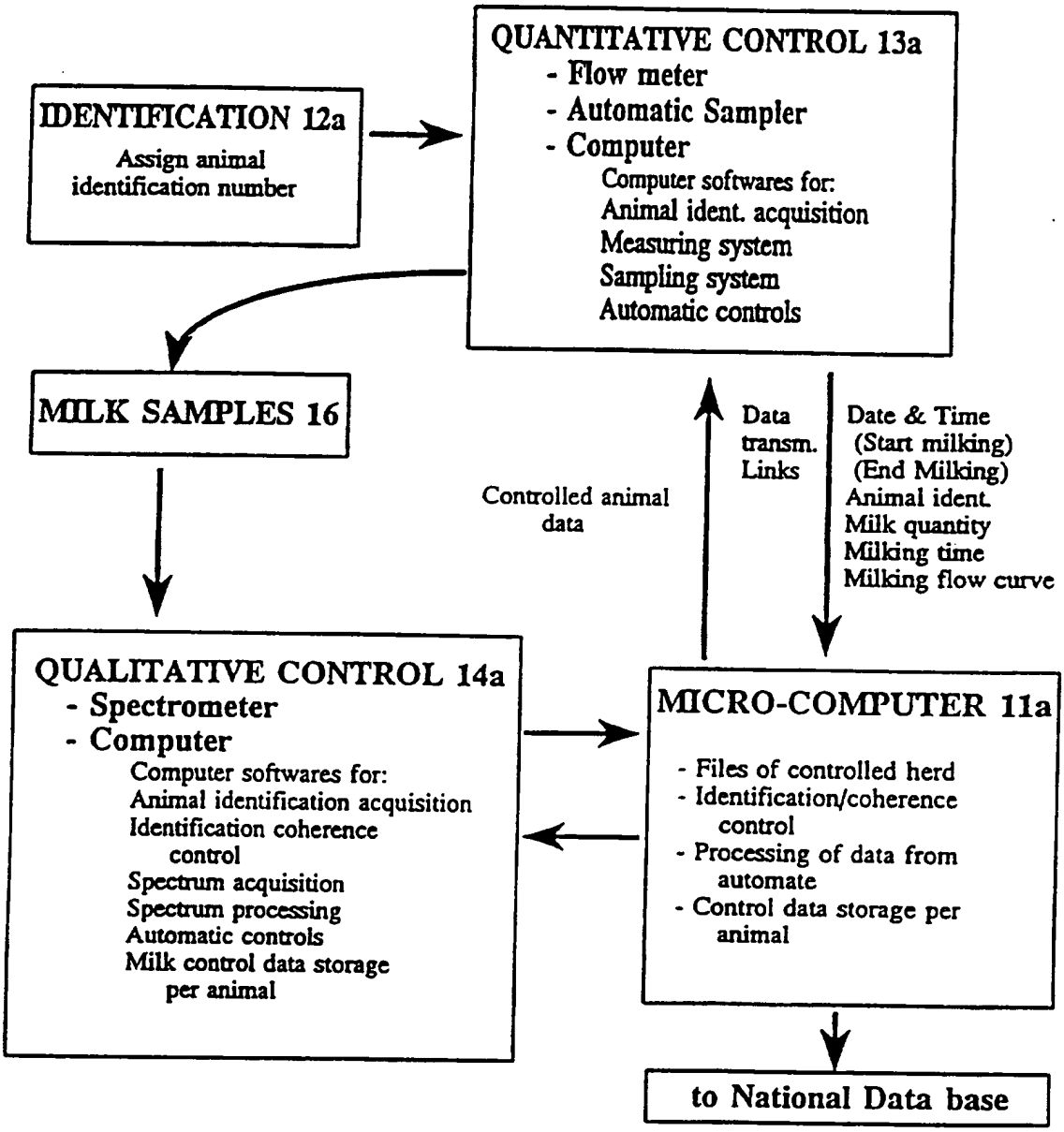

QUANTITATIVE CONTROL 13a
- Flow meter
- Automatic Sampler
- Computer
Computer softwares for:
Animal ident. acquisition
Measuring system
Sampling system
Automatic controls
IDENTIFICATION 12a
Assign animal identification number
MILK SAMPLES 16
Data transm. Links
Date & Time
(Start milking)
(End Milking)
Animal ident.
Milk quantity
Milking time
Milking flow curve
Controlled animal data
QUALITATIVE CONTROL 14a
- Spectrometer
- Computer
Computer softwares for:
Animal identification acquisition
Identification coherence control
Spectrum acquisition
Spectrum processing
Automatic controls
Milk control data storage per animal
MICRO-COMPUTER 11a
- Files of controlled herd
- Identification/coherence control
- Processing of data from automate
- Control data storage per animal
to National Data base

FIG. 3A

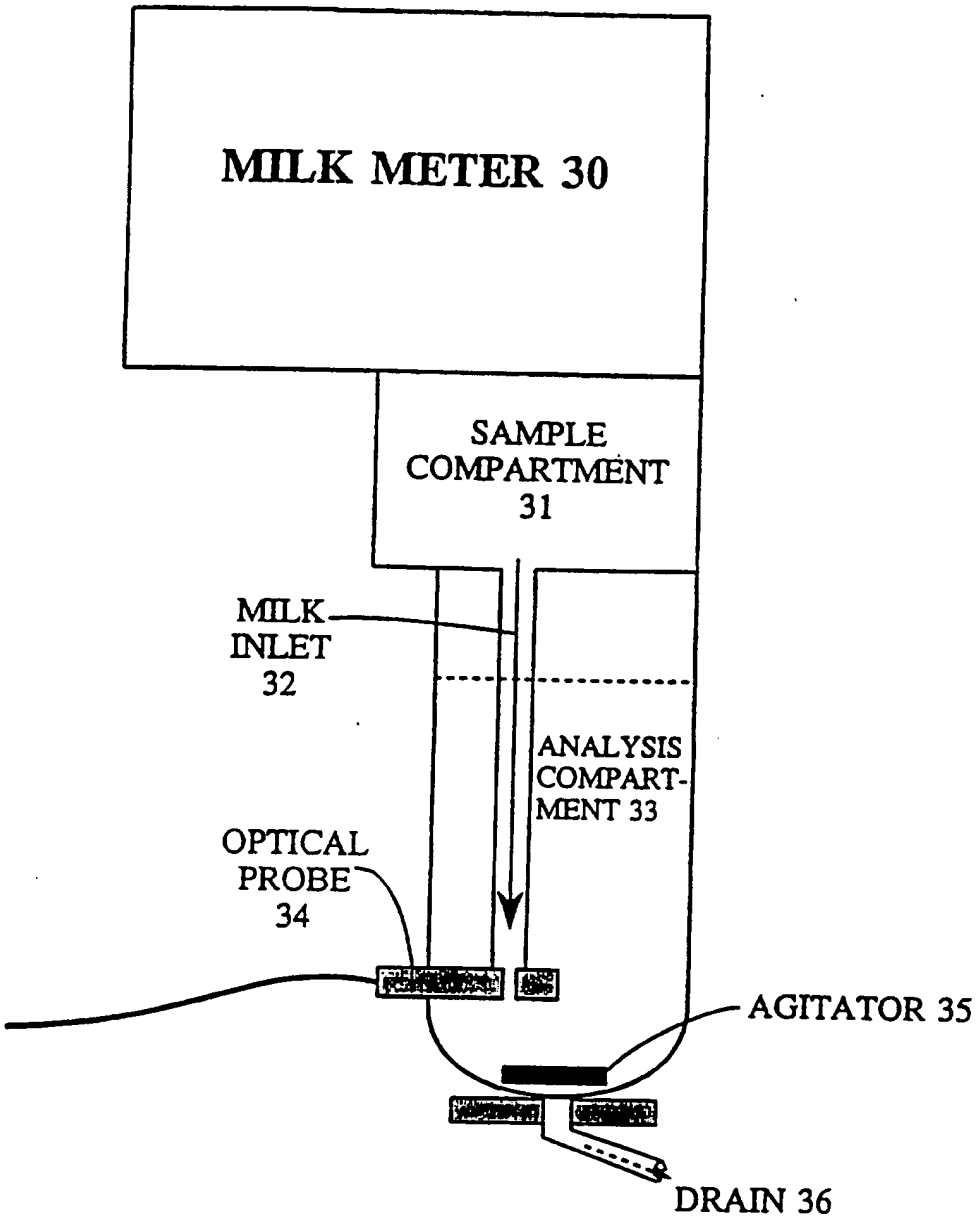

MILK METER 30
SAMPLE COMPARTMENT 31
MILK INLET 32
ANALYSIS COMPART-MENT 33
OPTICAL PROBE 34
AGITATOR 35
DRAIN 36

FIG. 3B

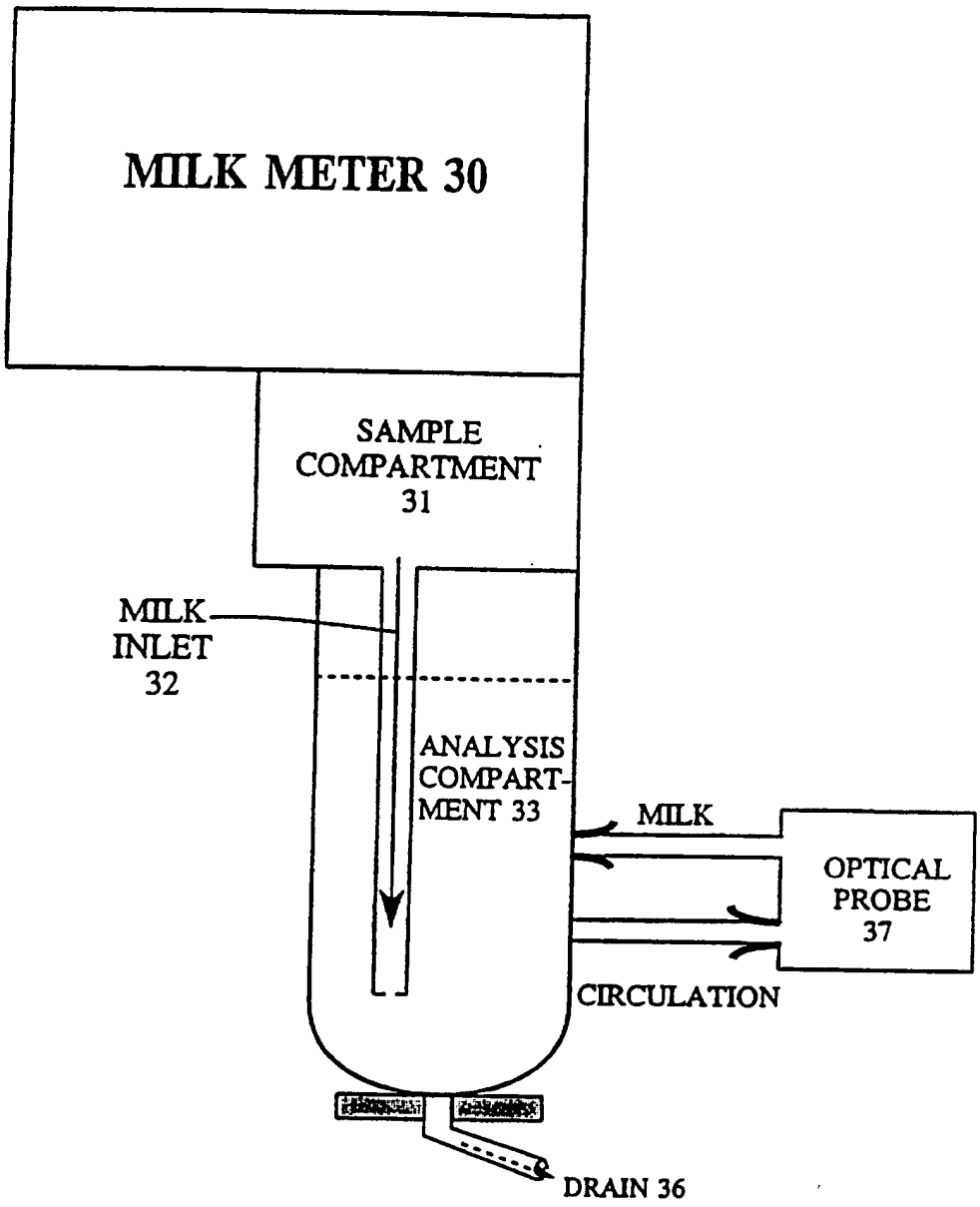
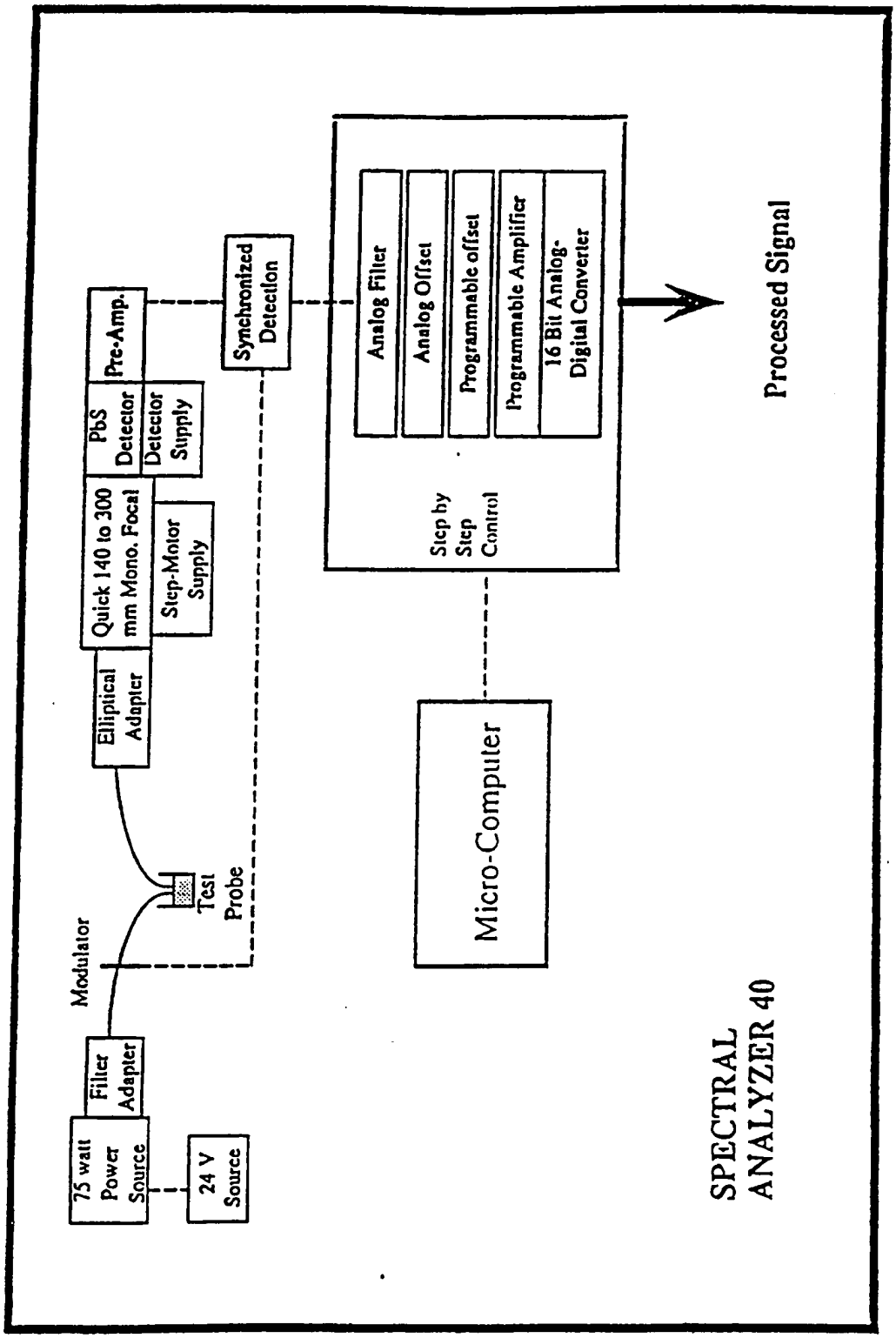

MILK METER 30
SAMPLE COMPARTMENT 31
MILK INLET 32
ANALYSIS COMPART-MENT 33
MILK
OPTICAL PROBE 37
CIRCULATION
DRAIN 36

FIG. 4


SPECTRAL ANALYZER 40
Micro-Computer
Step by Step Control
Analog Filter
Analog Offset
Programmable offset
Programmable Amplifier
16 Bit Analog-Digital Converter
Processed Signal
Synchronized Detection
Pre-Amp.
PbS Detector
Detector Supply
Quick 140 to 300 mm Mono. Focal
Step-Motor Supply
Elliptical Adapter
Test Probe
Modulator
Filter Adapter
75 watt Power Source
24 V Source

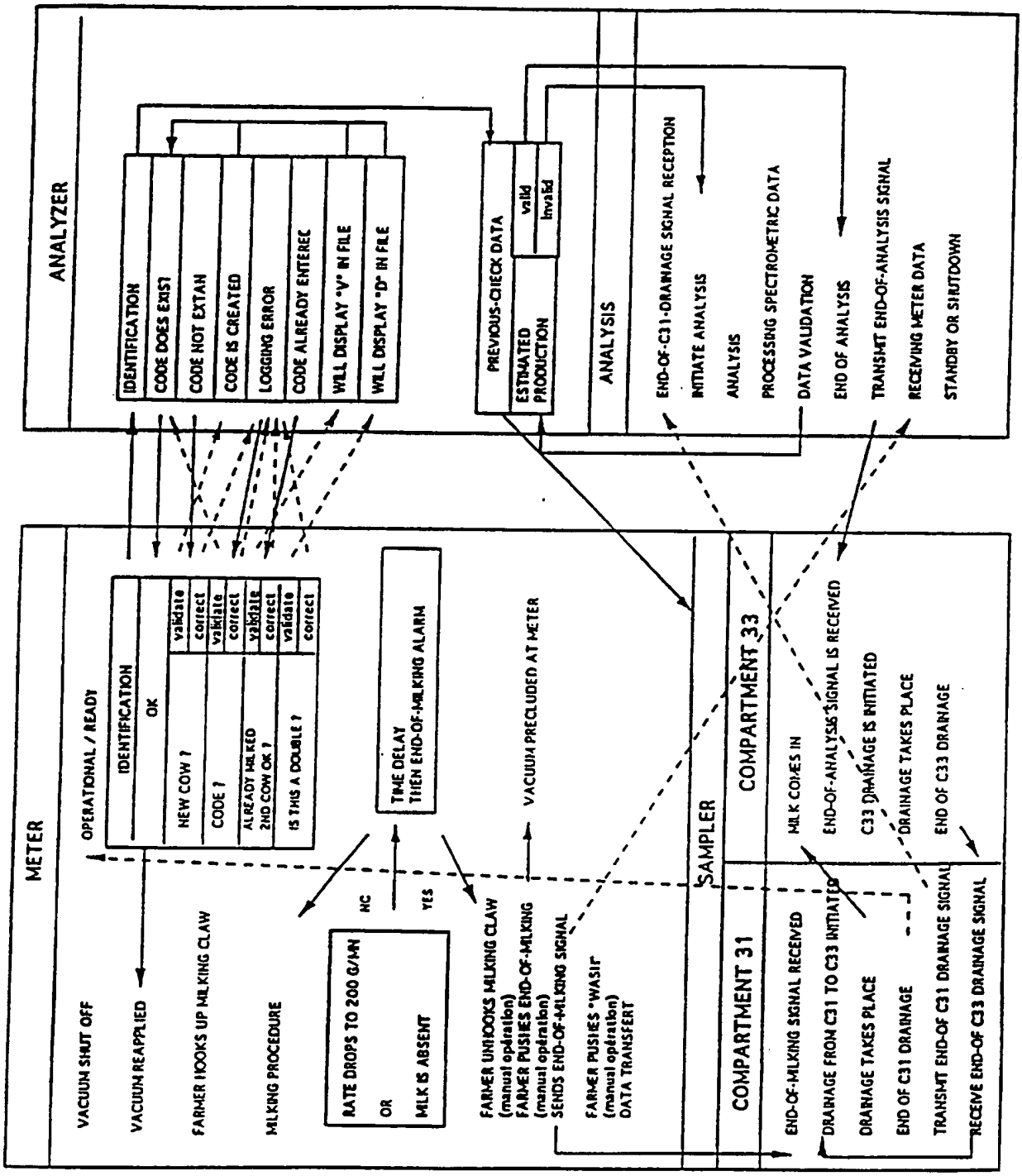

ANALYZER
IDENTIFICATION
CODE DOES EXIST
CODE NOT EXTAN
CODE IS CREATED
LOGGING ERROR
CODE ALREADY ENTEREC
WILL DISPLAY "V" IN FILE
WILL DISPLAY "D" IN FILE
PREVIOUS-CHECK DATA
valid
invalid
ESTIMATED PRODUCTION
ANALYSIS
END-OF-C31-DRAINAGE SIGNAL RECEPTION
INITIATE ANALYSIS
ANALYSIS
PROCESSING SPECTROMETRIC DATA
DATA VALIDATION
END OF ANALYSIS
TRANSMIT END-OF-ANALYSIS SIGNAL
RECEIVING METER DATA
STANDBY OR SHUTDOWN
METER
OPERATIONAL / READY
IDENTIFICATION
OK
NEW COW ?
validate
correct
CODE ?
validate
correct
ALREADY MILKED 2ND COW OK ?
validate
correct
IS THIS A DOUBLE ?
validate
correct
TIME DELAY THEN END-OF-MILKING ALARM
VACUUM PRECLUDED AT METER
VACUUM SHUT OFF
VACUUM REAPPLIED
FARMER HOOKS UP MILKING CLAW
MILKING PROCEDURE
RATE DROPS TO 200 G/MN
OR
MILK IS ABSENT
NO
YES
FARMER UNHOOKS MILKING CLAW (manual opération)
FARMER PUSHES END-OF-MILKING (manual opération) SENDS END-OF-MILKING SIGNAL
FARMER PUSHES "WASH" (manual opération) DATA TRANSFERT
SAMPLER
COMPARTMENT 33
COMPARTMENT 31
MILK COMES IN
END-OF-ANALYSIS SIGNAL IS RECEIVED
C33 DRAINAGE IS INITIATED
DRAINAGE TAKES PLACE
END OF C33 DRAINAGE
END-OF-MILKING SIGNAL RECEIVED
DRAINAGE FROM C31 TO C33 INITIATED
DRAINAGE TAKES PLACE
END OF C31 DRAINAGE
TRANSMIT END-OF C31 DRAINAGE SIGNAL
RECEIVE END-OF C33 DRAINAGE SIGNAL

FIG. 5

FIG. 6A

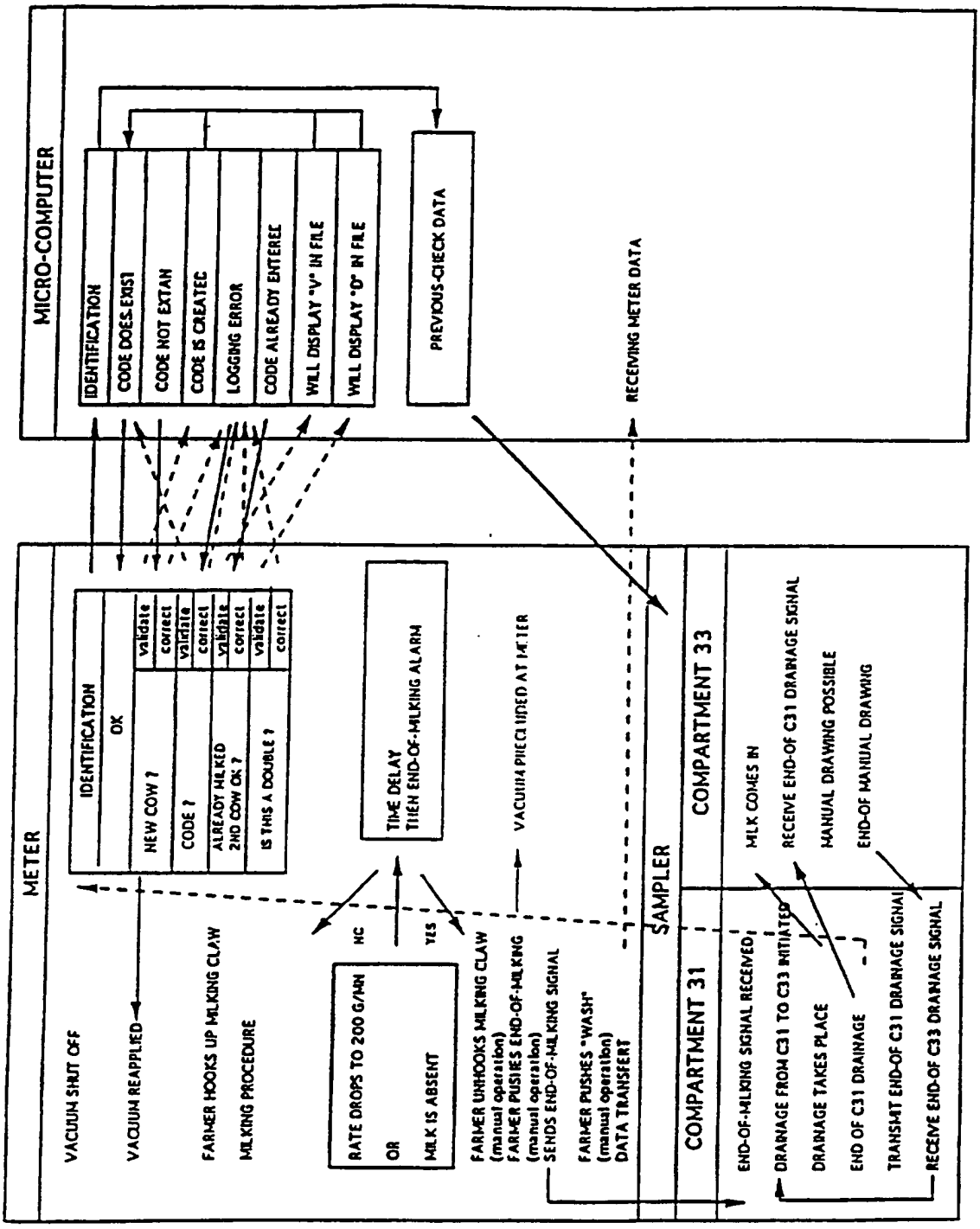
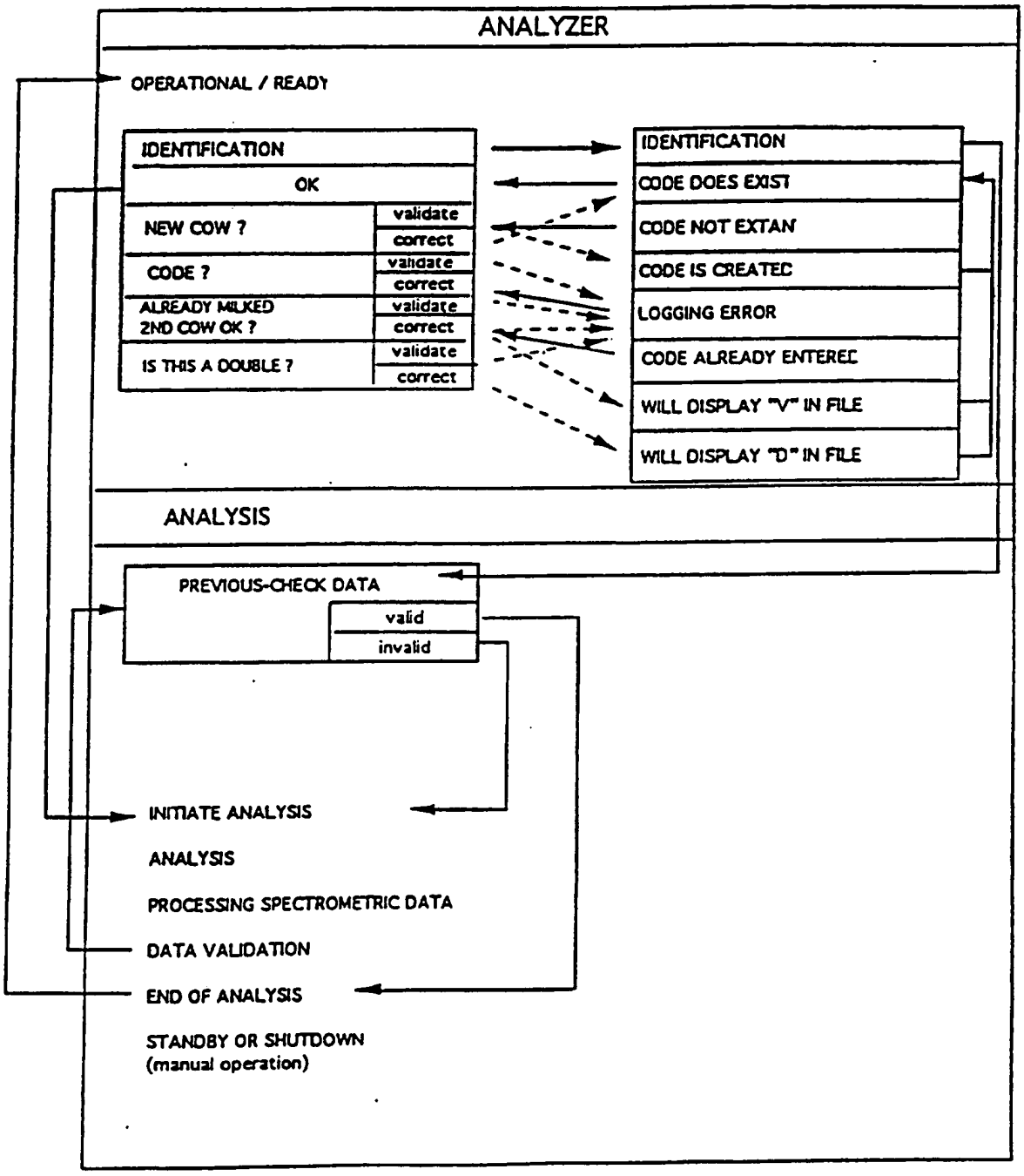

MICRO-COMPUTER
IDENTIFICATION
CODE DOES EXIST
CODE NOT EXTAN
CODE IS CREATED
LOGGING ERROR
CODE ALREADY ENTERED
WILL DISPLAY "V" IN FILE
WILL DISPLAY "0" IN FILE
PREVIOUS-CHECK DATA
RECEIVING METER DATA
METER
IDENTIFICATION
OK
NEW COW ?
CODE ?
ALREADY MILKED 2ND COW OK ?
IS THIS A DOUBLE ?
validate
correct
TIME DELAY
THEN END-OF-MILKING ALARM
VACUUM PRECLUDED AT METER
SAMPLER
COMPARTMENT 31
COMPARTMENT 33
VACUUM SHUT OFF
VACUUM REAPPLIED
FARMER HOOKS UP MILKING CLAW
MILKING PROCEDURE
RATE DROPS TO 200 G/MN
OR
MILK IS ABSENT
NO
YES
FARMER UNHOOKS MILKING CLAW (manual operation)
FARMER PUSHES END-OF-MILKING (manual operation) SENDS END-OF-MILKING SIGNAL
FARMER PUSHES "WASH" (manual operation) DATA TRANSFERT
END-OF-MILKING SIGNAL RECEIVED
DRAINAGE FROM C31 TO C33 INITIATED
DRAINAGE TAKES PLACE
END OF C31 DRAINAGE
TRANSMIT END-OF C31 DRAINAGE SIGNAL
RECEIVE END-OF C33 DRAINAGE SIGNAL
MILK COMES IN
RECEIVE END-OF C31 DRAINAGE SIGNAL
MANUAL DRAWING POSSIBLE
END-OF MANUAL DRAWING

FIG. 6B


ANALYZER
OPERATIONAL / READY
IDENTIFICATION
OK
NEW COW ?
validate
correct
CODE ?
validate
correct
ALREADY MILKED 2ND COW OK ?
validate
correct
IS THIS A DOUBLE ?
validate
correct
IDENTIFICATION
CODE DOES EXIST
CODE NOT EXTAN
CODE IS CREATED
LOGGING ERROR
CODE ALREADY ENTERED
WILL DISPLAY "V" IN FILE
WILL DISPLAY "D" IN FILE
ANALYSIS
PREVIOUS-CHECK DATA
valid
invalid
INITIATE ANALYSIS
ANALYSIS
PROCESSING SPECTROMETRIC DATA
DATA VALIDATION
END OF ANALYSIS
STANDBY OR SHUTDOWN
(manual operation)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 95/00679

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A01J5/017 A01J5/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A01J A01K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 564 023 (VAN DER LELY) 6 October 1993	1
A	see column 1, line 39 - line 52 see column 3, line 6 - column 4, line 6 see column 4, line 12 - column 5, line 17 see column 7, line 50 - column 9, line 14 see claims; figures	2,3,5,17
X	EP,A,0 551 959 (VAN DER LELY) 21 July 1993	1
A	see column 3, line 18 - line 37 see column 8, line 50 - column 9, line 42 see claims; figures	

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 December 1995	10. 01. 96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Piriou, J-C

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	NL,A,8 602 505 (VAN DER LELY) 2 May 1988 see page 1, line 17 - page 2, line 36 see claims; figures	1
A	& DATABASE WPI Week 8821 Derwent Publications Ltd., London, GB; AN 88-145460 & NL,A,8 602 505 (VAN DER LELY) see abstract	1
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